

Section of the History of Medicine.

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Jābir ibn Ḥayyān.

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No other chemist of Islām can compare with Jābir ibn Ḥayyān in celebrity. Yet up to the present time there has been no attempt to gather together the information concerning him which is scattered through Muḥammadan chemical literature. The vexed question of the possible identity of Jābir with the famous author, "Geber," of the *Summa perfectionis* and other works well known in a Latin form—a question which has provoked much controversy during the last fifty years—is reserved for discussion at a later date. It is obvious that a comprehensive study of the works of Jābir ibn Ḥayyān is an essential prerequisite. The conclusion of the pseudepigraphists, namely, that Jābir is not identical with Geber, may be correct, but it is impossible to deny that the evidence upon which this conclusion has hitherto been based is inadequate, often untrustworthy and not seldom absolutely incorrect. While, therefore, this article is primarily intended to be a contribution to our knowledge of the authentic and historical Jābir, it may also throw light indirectly upon the "Geber" tradition.

(1) BIRTHPLACE AND LIFE.

Al-Nadīm¹ says that Jābir's full name was Abū 'Abdullah Jābir ibn Ḥayyān ibn 'Abdullah al-Kūfi. He is, however, almost always called elsewhere Abū Mūsā, not Abū 'Abdullah; he may have had two sons, Mūsā and 'Abdullah, in which case either name would be correct. Al-Qiftī states in his *History of the Sages*² that Jābir excelled in the natural sciences, especially that of chemistry, and wrote numerous well-known books. He was, in addition, skilled in philosophy and esoterics, and was a Sūfi. Ibn Khallikān³ describes Jābir as a pupil of the Imām Ja'far al-Ṣādiq (699-765 A.D.), a tradition which is mentioned also in the *Fihrist* and in certain of Jābir's own writings. Hājji Khalifa's statement that Jābir was a pupil of Khalid ibn Yazid ibn Mu'awiya (died 704 A.D.) need not be taken literally, and probably means simply that Jābir was a student of Khalid's books: it is, of course, well-known

¹ *Kitāb al-Fihrist*, ed. Fluegel, p. 354.

² Ed. Lippert, p. 160.

³ Ed. de Slane, ii, 300.

that Khālid was the earliest Muslim of rank to take an interest in chemistry, which he is said to have learnt from the monk Marianus.

The Fihrist gives the titles of several books which Jābir wrote for the Barmekides, and in his *Great Book of Properties* Jābir¹ refers by name to Khālid, Ja'far and Yaḥyā, members of the Barmekide family. He seems, indeed, to have been on terms of some intimacy with them, as we shall see later.² The Barmekides enjoyed the favour of Hārūn al-Rashīd for seventeen years—from 786 to 803 A.D.—so that we can safely place Jābir's youth prior to 765, the date of the death of Ja'far al-Sādiq, and his manhood in the last quarter of the eighth century. The exact date of his birth is unknown, as is that of his death. According to Ḥājji Khalifa³ he died in A.H. 160, that is 776/777 A.D., but this date is obviously incorrect, from the above considerations. Aidamir al-Jildakī (died about 1360 A.D.), who was extraordinarily well-informed about the chemists of Islām, states⁴ that Jābir became involved in the fall of the Barmekides in 803 A.D. and had to fly for his life to Kūfa, where he lived in retirement till the days of the Caliph al-Ma'mūn, who succeeded to the throne in 813.

From these facts it would appear reasonable to place Jābir's birth somewhere about the years 730-735 and his death some eighty years later; it must, however, be definitely stated that these dates are only conjectural. All that we can be certain of is that he flourished during the latter half of the eighth century, and that the date given by Ḥājji Khalifa for his death is much too early.⁵

Jābir is variously described as "of Tūs,"⁶ "of Tarrūs,"⁷ "of Kūfa,"⁸ "of Khorāsān,"⁹ and also as a Sabæan (of Harrān).¹⁰ No information as to his birthplace is to be found in his writings, but there are traces of Sabæan doctrine in some passages; it would, however, be unsafe to assume that his belief in the influence of the stars necessarily implies that he was a Sabæan, since this belief was common to all his contemporaries. Practically all the authorities agree in stating that he lived at Kūfa for at least part of his life. The Fihrist¹¹ relates that, over a century after Jābir must have died, while some houses in the quarter of Kūfa known as the *Bāb al-Sha'm* were being demolished a mortar containing over 200 lb. of gold was found on the site of Jābir's laboratory.

Since the Barmekides were in constant attendance at the Court at Baghdād, it may be assumed with reason that for some years Jābir lived in the capital of the empire. Of his life there we know very little, but he paints one or two sketches, in the *Great Book of Properties*,¹² which show us that he practised

¹ MS. Brit. Mus. Or. 4041.

² See p. 48, 55.

³ Ed. Fluegel, v, 34, 79.

⁴ *Nihāyat al-Talab*, ii, end.

⁵ It is possible that H. Kh., taking literally the statement that Jābir was a "pupil" of Khālid ibn Yazīd, considered that his death could not be placed later than A.D. 776. I find no other authority for H. Kh.'s date, which, however, Brockelmann (*Gesch. d. arab. Litt.* i, 241) accepts.

⁶ *Kitāb al-Mawāzīn* (MS. Leyden, Arabe 440. See Berthelot, *La Chimie au Moyen Âge*, iii, 139, &c.).

⁷ (a) See Wüstenfeld, *Gesch. d. arab. Aertze und Naturforscher*, p. 12. (b) Ibn Khall., ii, 300

⁸ *Fihrist*, loc. cit.

⁹ *Fihrist*, p. 355.

¹⁰ d'Herbelot, *Bibliothèque Orientale*, p. 360.

¹¹ Loc. cit.

¹² See note (above).

medicine as well as chemistry. Thus he says¹ that he cured a valuable slave-girl, belonging to Yaḥyā ibn Khālīd, by means of an elixir he had prepared, and that Yaḥyā was so impressed by the cure that he began to study science "and persevered until he knew many things; but his son, Ja'far, was cleverer than he."

He seems to have suffered persecution at times. The Fihrist says that he did not long dwell in one spot, as he feared for his life, and Al-Jildakī² affirms that "Jābir ibn Ḥayyān narrowly escaped death on many occasions, and met with affliction and violence on account of this science [i.e. chemistry] from the hands of envious and evilly-disposed people. He finally had to explain some of the science openly to Al-Rashīd and to Yaḥyā ibn Barmak and his two sons Al-Faḍl and Ja'far, whence their riches."

(2) WORKS.

Jābir was a voluminous writer. His own "Fihrist" or list of his writings, which was used by Al-Nadīm,³ is unfortunately now lost. Al-Nadīm's list is incomplete, and in one case at least an error has been made by Fluegel and his collaborators in editing the titles given in Al-Nadīm's *Kitāb al-Fihrist*.⁴ Berthelot's translation⁵ of the titles given in the *K. al-Fihrist* is often inaccurate and unintelligent. The majority of the books of Jābir here mentioned have been lost, so that no useful purpose would be served by reproducing the list in its entirety. We shall, however, give the names of (a) those books mentioned in the Fihrist which are still extant, either complete or in fragments; (b) those which have some interest for other reasons, and (c) those which are not mentioned in the *K. al-Fihrist*, but which are known in MS. or printed, or known by title only.

(A) BOOKS MENTIONED IN THE FIHRIST OF WHICH MSS. OR PRINTED EDITIONS ARE EXTANT.

(1) *Kitāb Istuqus al-'Uss al-Awwal*. Lithographed. India, 1891. Berthelot (op. cit.) naively translates this title "*Le Livre d'Etagēs, le premier myrte*," thus confessing ignorance of the meaning of *istuqus* and misreading *ūs* (myrtle) for *'uss* (base or foundation). *Istuqus* seems to be the Greek *ἱερῆκός*, which is used by Aristotle (*Metam.*) in the sense of firm, solid, or substantial. Here it is used in the sense of "foundation," so that the title may be translated "*The Book of Foundation, the First Base*." That this is the correct rendering is shown by Jābir's own explanation in his book (No. 4) *Tafsīr Kitāb al-Istuqus* ("Commentary on the Book of Foundation") where he says that he has placed the Book of Foundation in three parts [of which the present is the first], at the beginning of his "112 Books," because it contains "the sum of the meanings" of the rest, and so serves as an introduction or prolegomena to them. "To whomsoever understands it is manifest all that which is in the 112 Books." "*Istuqus*," he says, "in the Greek language signifies the foundation of a building."

Salmoné⁶ gives the word as *istags*, meaning "the four elements," while Dozy⁷ gives *istugis*, quoting Freytag, and *ustuqussu* on the authority of Schiaparelli.

¹ Op. cit., *maqāla* 6.

² *Nihāyat at-Talab*, ii, end.

³ *Kitāb al-Fihrist*, ed. Fluegel.

⁴ *Vide infra*, pp. 50, 51.

⁵ That is, the translation published by Berthelot, *op. cit.*, iii, 32-36. The translation was actually made by O. Houdas.

⁶ *Arabic-English Dictionary*, London, 1890, p. 13.

⁷ *Suppl. aux dictionnaires arabes*, Leyden, 1881.

(2) *K. Istuqus al-'Uss al-Thānī*. Lithographed. India, 1891. The second part of the same work.

(3) *K. Istuqus al-'Uss al-Thālith*. Lithographed. India, 1891. The third part of the above, apparently that given in the *Fihrist* as (No. 43) *K. Istuqus* merely.

(4) To the above should be added the *Kitāb Tafṣīr al-Istuqus*. Lithographed. India, 1891. "An Explanation of the *Istuqus*." *Not mentioned in the Fihrist*.

(5) *K. al-Wāhid al-Auwal*. "The First Book of Unity." Bibl. Nat. *Arabe* 2606. Apparently the same as the *K. al-Wāhid al-Kabīr* in the *Fihrist*.

(6) *K. al-Wāhid al-Thānī*. "The Second Book of Unity." Bibl. Nat. *Arabe* 2606. Apparently the same as the *K. al-Wāhid al-Saghīr* in the *Fihrist*.

(7) *K. al-Rukn*. "The Book of the Fundamental Principle." This is probably the same as the *K. al-Arkān* [*arkān* is the plural of *rukṇ*], from which a short quotation is made in section 7 of the *Rutbatu'l-Hakīm* ascribed incorrectly to Maslama al-Majrītī. A *K. al-Arkān al-Arba'a* is mentioned by Jābir in his *K. Nar al-Hajar*, q.v.

(8) *K. al-Bayān*. "The Book of Explanation." Lithog. India, 1891.

(9) *K. al-Nūr*. "The Book of Light." Lithog. India, 1891. Steinschneider (*Die europ. Uebersetz. a. d. Arabischen*, A, 73; Wien, 1904), speaking of Geber's *Lib. Fornacum*, says "Unter Djabir b. Hajjans Schriften im *Fihrist*, S. 355, kommt nur Z. 29 'Kitab al-Nur' vor, welches aus Tannur entstanden sein könnte." However, the *K. al-Nūr* is an entirely different work from the *Lib. Fornacum*. Incidentally it may be mentioned that the translator of the *Lib. Fornacum*, given in *Artis chem. principes* (Basle, 1572) as Rodogerus Hispalensis (see Kopp, *Beiträge z. Gesch. der Chemie*, III, 34—not 84 as quoted by Steinschneider), is called 'Roger Bacon Hispalensis' in B. M. *Sloane* 1118 fol. 60—a fifteenth century MS. 'Roger Bacon' here is apparently a misreading for Rodogerus. Who Rodogerus was I have not been able to discover.

(10) *K. al-Zaibaq*. "The Book of Mercury." Berthelot (op. cit., iii) prints two "Books of Mercury"—*K. al-Zaibaq al-Sharqī* (Book of Eastern Mercury) and *K. al-Z. al-Gharbī* (Book of Western Mercury) from the Leyden MS. *Arabe* 440. They are also in Bibl. Nat. *Arabe* 2606.

(11) *K. al-Sha'ar*. "The Book of Hair." Brit. Mus. *Addl.* 7722, No. 5.

(12) *K. al-Tabwīb*. "The Book of Arrangement by Chapters." This is the Bibl. Nat. MS. *Arabe* 2606. It is also quoted by Al-Tughrā'ī, Brit. Mus. MS. *Or.* 8229.

(13) *K. al-Durratu'l-Maknūna*. "The Book of the Guarded Pearl." A MS. of this title, anonymous, is found among works of Jābir in the British Museum. MS. *Addl.* 7722, No. 11.

(14 and 15) *K. al-Shams*. "The Book of the Sun, or Gold," and *K. al-Qamar*, "The Book of the Moon, or Silver," are probably extracted from the *K. al-Ajsūd al-Sab'a*, "The Book of the Seven Metals," quoted several times by Al-Jildakī in his *Nihāyat at-Talab*. See also Bibl. Nationale MS. *Arabe* 2606, and Nos. 71 and 72, below.

(16) *K. al-Tarākīb*. "The Book of Combinations." Bibl. Nat. *Arabe* 2606. This possibly is the *K. al-Tarkīb* of the *Fihrist*.

(17) *K. al-Haiyawān*. "The Book of Animals." A book of Jābir's, entitled *K. Hayyatu'l-Haiyawān*, "The Book of the Life of Animals," is quoted by Al-Jildakī (op. cit., vol. i).

(18) *K. al-Asrār*. "The Book of Secrets." This may be the same as the *K. sirr al-Asrār*, "The Book of the Secret of Secrets," of which there is a MS. in the Brit. Mus. (*Addl.* 23418, No. 14) and which is mentioned with quotations several times by Al-Tughrā'ī (Brit. Mus. *Or.* 8229). There is a Latin MS. *Secreta Secretorum* ascribed

to "Geber" in Gonville and Caius College, No. 181, and in Corpus Christi College, Cambridge, No. 99.

(19) *K. al-Ard*. "The Book of the Earth." A work of Jābir, *K. ard al-Hajar*, "The Book of the Earth of the Stone," is printed by Berthelot (op. cit., iii) from the Leyden MS. *Arabe* 440. It is also in Bibl. Nat. *Arabe* 2606.

(20) *K. al-Tarkīb al Thānī*. "The Second Book of Combination." Bibl. Nat. *Arabe* 2606.

(21) *K. al-Khawāss*. "The Book of Properties." Brit. Mus. Or. 4041 and *Addl.* 23419 No. 2.

(22) *K. al-Tadhkīr*. "The Book of Admonition," or "The Book of Rendering Masculine." There is an anonymous MS. of this title, occurring among works of Jābir, in the Brit. Mus. (*Addl.* 7722, No. 12).

(23) *K. al-Istitmām*. "The Book of Demand (or Search) for Perfection." A few quotations are made from this book by Al-Tughrā'i (Brit. Mus. Or. 8229), and also by Al-Jildakī in his *Nihāyat at-Talab*. The title corresponds to that of the *Liber de Investigatione Perfectionis* of "Geber."

(24) *K. al-Aḥjār*. "The Book of Stones." A *K. al-Hajar* ("Book of the Stone"), of Jābir, was lithographed in India in 1891.

(25) *K. al-Rawda*. "The Book of the Garden." Quoted by Al-Jildakī in vol. ii of his *Nihāyat at-Talab*.

(26) *K. al-Munāfi'*. "The Book of Advantages." A book by Jābir entitled *K. Munāfi' al-Hajar*, "The Book of Advantages of the Stone," is in the Berlin MS. 4199, i.

(27) *K. al-Idāḥ*. "The Book of Explanation." Lithographed. India, 1891.

(28) *K. Musahhiḥāt Flātūn*. "The Book of Emendations of Plato." MS. at Constantinople (Defteri Kutubhāne'i Rāgib Pāshā, 96, No. 4, Stambul, 1310 A.H.).

(29) *K. al-Damīr*. "The Book of Secret Thoughts [or, 'of the Pronoun']." Bibl. Nat. *Arabe* 2606. This is mentioned by Al-Jildakī, op. cit., vol. ii, end, under the title *K. al-Damīr fī Khawāss al-Iksīr*, "The Book of Secret Thoughts on the Properties of the Elixir."

(30) *K. al-Mawāzīn*. "The Book of Balances." Printed by Berthelot (op. cit., iii, p. 105 of Arabic text) from the Leyden MS. *Arabe* 440. I presume this work is the *Liber de Ponderibus artis*, Borellius, *Bibl. Chim.*, Paris, 1654, p. 103.

(31) *Kutub al-Mulk*. "The Books of Dominion [or, 'of the Kingdom']." In the Fihrist, Jābir says, "I composed a book known as the Books of the Kingdom." This appears to indicate that the book referred to consisted of two or more smaller books included under one title, and this is borne out by the following facts: Berthelot (op. cit., iii) printed the text of a *K. al-Mulk* from the Leyden MS. *Arabe* 440; there is another copy of the same work in Bibl. Nat. *Arabe* 2605. But this *K. al-Mulk* is quite different from another of the same title lithographed in India in 1891.

A *K. al-Mulk* of Jābir seems to have been translated into Latin, as a *Lib. Regni* of "Geber" is mentioned by Borellius (*Bibl. Chim.*, Paris, 1654, p. 103), and by Carini, *Rivista Sicula*, vii, pp. 175 and 179.

(32) *K. al-Riyād*. "The Book of Gardens." Bodl. *Marsh* 70, Brit. Mus. *Addl.* 7722, No. 5.

(B) BOOKS OF INTEREST, UNKNOWN IN ARABIC, OR REQUIRING SPECIAL MENTION.

(33) In the list given in the Fihrist occurs the title *Kitāb ilā Qalamūn*. Berthelot translates this as "Livre à Qalamoc; peut-être faut-il lire 'Le livre du Caméléon.'" Fluegel, however, admits that the reading *ila Qalamūn* is conjectural (*K. al-Fihrist*, p. 193) and says that all the codices read *abī Qalamūn* (without the diacritical point

under the *b*). His emendation to *ilī Qalamūn* is therefore open to question, especially as his further "identification" of *Qalamūn* is very doubtful. In point of fact, there can be little doubt that *abī Qalamūn* is correct: the title would then read "The Book of Abū Qalamūn." Now Abū Qalamūn is the Arabic nickname of the *jasper*, as is shown by Mas'ūdī's description (II, 437) of the "Chatons nommés *baqalamūn*, qui offrent à l'œil des nuances chatoyantes et variées entre le rouge, le vert, le jaune, &c. . . . Le chatolement résulte de l'éclat et de la limpidité de la pierre, et aussi de l'angle sous lequel l'œil la considère." (Barbier de Meynard's translation, Paris, 1863.) See also Ibn al-Baitār, Sontheimer's translation, II, 603 (Stuttgart, 1840): "In the East the jasper (*lit.* the Ethiopian *Yāqūt*) is called *Abū Qalamūn*."

(34) The *Fihrist* mentions a *Kitāb al-BDWH*, which Berthelot misreads as *K. al-Badouh*, leaving the meaning of *Badouh* undecided. The true reading is that given above, viz., *BDWH*. This combination of letters, representing the numerical value 2468, is commonly employed as a kind of talisman to facilitate birth, or as a love-charm, &c. See de Sacy, *Chrest. arabe*, III, 365 (Paris, 1826).

(35) *K. al-Mujarradāt*. (*Fihrist*.) "The Book of Extracts." This is no doubt the *Liber Denudatorum* quoted in the *De aluminibus et salibus* ascribed to Rhazes (Al-Rāzī). *Jarrada* may mean "to strip naked" as well as "to make extracts from a book." See Dozy, *op. cit.*, *sub voce*. The *Lib. Denudatorum* is mentioned by Borellius, *op. cit.*, p. 103.

(36) *K. al-Tasrif*. "The Book of Mutation." This seems to be the *Liber Mutatorium* quoted in the *De aluminibus et salibus*. See No. 35, *supra*. Berthelot (*op. cit.*, iii, 34) translates the title "*Livre de la Désinence*," but queries his own translation.

(37) *K. al-Thalathīna Kalima*. "The Book of Thirty Words." A Latin MS., entitled *Liber de XXX Verbis*, anonymous, follows the *Liber de Septuaginta* ascribed to "Geber" in the British Museum MS. *Arundel* 164.

(38) *K. Khamsata 'Ashara*. "The Book of Fifteen." A Latin MS. entitled *Liber XV*, ascribed to "Geber," is in the library of Trinity College, Cambridge (No. 1363, ff. 137 v.-140 v. *sæc.* xv).

(39) *K. Musahhihāt Suqrūt*. "The Book of Emendations of Socrates." (Cf. No. 28.) May this be the same as *Ad laudem Socratis dixit Geber?* Bodl. *Ashmole* 1416, f. 148.

(40) *K. al-Sab'īna*. "The Book of Seventy." This has already been fully discussed by Berthelot (*op. cit.*, i, chap. ix, p. 320, and *Archéologie*, Paris, 1906). Other Latin MSS. of the work (*Liber LXX*) occur in the British Museum, *Addl.* 10764, fol. 126 v.-127 v., 128-138 v., and *Arundel* 164.

(41) *K. Sharh al-Majista*. "The Book of Comment on the *Almagest*." [*Fihrist*.] A "Comment on Ptolemy," ascribed to Geber, was translated by Gerard of Cremona. MSS. are in Corpus Christi College, Oxford (No. 233, ff. 32-67), the Bodleian (*Ashmole*, 357, ff. 97-178 v.), and Cambridge University Library (Mm. II, 18, ff. 2-49 and Ii. I, 13, ff. 58 v.-60).

(42) *K. al-Wasiyya*. "The Book of the Testament." British Museum, *Addl.* 7722, No. 3. MSS. of the Latin work *Geberi Testamentum* are in Trinity College, Cambridge (925, and 1380 ff. 134-140); the work was also printed many times, e.g., Manget's *Bibl. Chem. Curiosa*, I, 562. I have not compared the Arabic with the Latin, so I cannot say whether the two are identical or not.

(43) *K. al-Mulāgham*. "The Book of Amalgams." Mentioned in the *Rutbatu'l-Hakīm*.

(44) *K. al-Khūlis*. "The Book of Sincerity."

(45) *K. al-Jam'*. "The Book of Collection."

These two (xii and xiii) are mentioned by Jābir in his *Book of Properties* (A. 21,

supra). Hoefer (*Hist. de la Chimie*, I, 74), suggested that the *K. al-Khālīs* might be the original of the *Summa perfectionis*, but gave no reason. Steinschneider (op. cit., p. 21) errs in saying that Hoefer quotes Bibl. Nat. *Arabe* 1083 (ancien fonds) as containing a MS. of the *K. al-Khālīs*; the No. 1083 is given by Hoefer as a reference to Ḥājji Khalifa (ed. Fluegel, 1835-1858). So far as I am aware, no MS. of the *K. al-Khālīs* is extant.

(C) BOOKS NOT MENTIONED IN THE FIHRIST BUT (1) EXTANT, OR
(2) KNOWN BY TITLE ONLY.

1.—*Extant, complete or fragmentary.*

(46) *Sundūq al-Hikma*. "The Casket of Wisdom." MS. in Royal Library at Cairo.

(47) *Kitāb Ikhrāj mā fi'l-Qauwat ilā al-Fi'l*. "The Book of Extraction from Potentiality to Actuality." MS. Royal Library, Cairo.

(48) *K. al-Hudūd*. "The Book of Definitions." MS. Royal Library, Cairo.

(49) *Kashf al-Asrār wa Hatku'l-Astūr*. "The Unveiling of Secrets and the Rending of Veils." Brit. Mus. Addl. 7722 No. 4. MS. Royal Library, Cairo. Published with a rendering into English by R. Steele, London, 1892 (Luzac & Co.).

(50) *Risāla (fi'l Kimiā)*. "Letter (on Chemistry)." MS. Royal Library, Cairo.

(51) *K. fī 'Ilm al-San'ati'l-Ilāhiya wa'l-Hikmatil-Falsafiya*. "The Book of Knowledge of the Divine Art and Philosophical Wisdom." MS. Royal Library, Cairo.

(52) *Khawāss al-Iksīr al-Dhahab*. "The Properties of the Elixir of Gold." Paris, Bibl. Nat. *Arabe*, 2625, No. 6. Translated into English by E. J. Holmyard, *Science Progress*, 1922, p. 258, where it is incorrectly stated to be from the *Kitāb al-Khawāss*, No. 21 (q.v.).

(53) *Kitāb al-Muqābila wa'l-Mumāthila*. "The Book of Comparisons and Similitudes." Berlin, 4177.

(54) *K. al-Rahma*. "The Book of Mercy." Printed by Berthelot (op. cit., iii) from the Leyden MS. *Arabe* 440. This is really a work of Abu 'Abdullah Muhammad ibn Yahyā containing many quotations from Jābir; the author names himself twice in the course of the book.

(55) *K. al-Rahma al-Saghīr*. "The Little Book of Mercy." Printed by Berthelot (loc. cit.) from the Bibl. Nat. MS. 2605. Also lithog., India, 1891.

(56) *K. al-Tajmīl*. "The Book of Concentration." Printed by Berthelot (loc. cit.) from the Leyden MS. *Arabe* 440.

(57) *K. al-Tajrīd*. "The Book of Abstraction." Lithog. India, 1891. Jābir says that he wrote this after the "112 Books," and that it forms one of the books of the series on the "Balance."

(58) *K. al-Sahl*. "The Book of Ease." Brit. Mus. Addl. 7722, No. 1.

(59) *K. al-Sāfī*. "The Book of Purity." Brit. Mus. Addl. 7722, No. 2.

(60) *K. al-Ihrāq*. "The Book of Combustion." Quoted by Al-Jildakī in vol. i of his *Nihāyat al-Talab*.

(61) *K. al-Taklīs*. "The Book of Calcination." Quoted by Al-Jildakī (op. cit., vol. ii).

(62) *K. al-Abdāl*. "The Book of Exchanges." Quoted by Al-Jildakī (op. cit., vol. ii).

(63) *K. Zuh'r al-Riyād*. "The Book of the Flower of the Garden." Quoted by Al-Jildakī (op. cit., vol. ii).

(64) *K. al-Usūl*. "The Book of Roots [= fundamental principles]." Brit. Mus. Addl. 23418, No. 13. Latin translation (?) mentioned by Borellius, op. cit., p. 102. (Liber Radicum.)

(65) *K. Muhaj al-Nufūs*. "The Book of the Essences of Spirits." Quoted by Al-Jildakī (op. cit., vol. ii).

(66) *K. sharh K. at-Rahma*. "The Book of Comment upon the Book of Mercy." Quoted by Al-Jildakī (op. cit., vol. i).

(67) *K. al-Afwa*. "The Book of Pardon." Quoted by Al-Tughrā'ī (Brit. Mus. Or. 8229).

(68) *K. al-Rūha*. "The Book of Repose," otherwise known as *K. al-Da'āwa*, "The Book of Chains." Quoted by Al-Tughrā'ī, loc. cit.

(69) *K. al-Sirr al-Maktūm*. "The Book of the Hidden Secret." Quoted by Al-Tughrā'ī, loc. cit.

(70) *K. al-'Awālim*. "The Book of Worlds." Quoted by Al-Tughrā'ī, loc. cit. See also *K. al-Mawūzīn*, ed. Berthelot, op. cit., iii, where a work of a similar title is mentioned. There is a MS. of this in Bibl. Nat. *Arabe* 2606.

(71) *K. al-Dhahab*. "The Book of Gold." Bibl. Nat. *Arabe* 2606.

(72) *K. al-Fudḍa*. "The Book of Silver." *Ibid.*

(73) *K. al-Nuhās*. "The Book of Copper." *Ibid.*

(74) *K. al-Hadīd*. "The Book of Iron." *Ibid.*

(75) *K. al-Uṣrūb*. "The Book of Lead." *Ibid.*

(76) *K. al-Qaṭ'ī*. "The Book of Tin." *Ibid.*

(77) *K. al-Khārsīnī*. "The Book of Tutenag." *Ibid.* Khārsīnī or Khār of China, often called *Katesim* in Latin translations from the Arabic, is probably an alloy containing zinc, copper and iron. Later on, according to Dozy (op. cit.) the name was applied to zinc itself.

(78) *K. al-Ijāz*. "The Book of Abbreviation." *Ibid.*

(79) *K. al-Hurūf*. "The Book of Letters." *Ibid.*

(80) *K. al-Kabīr*. "The Great Book." *Ibid.*

(81) *K. Nūr al-Hajar*. "The Book of Stone." *Ibid.* Also printed by Berthelot (op. cit., iii) from the Leyden MS. *Arabe* 440.

2.—Titles only known.

(82) *K. al-Arba'*. "The Book of Four."

(83) *K. al-Tas'īd*. "The Book of Sublimation."

(84) *K. al-Atyūn*. "The Book of Clays."

(85) *K. al-Tanqīyya*. "The Book of Cleansing."

These four books are mentioned, without quotation, by Al-Jildakī in the *Nihāyat at-Talab*.

(86) *K. al-Tanzīl*. The Book of Reduction *per descensum*." Mentioned by Jābir in his "Book of Properties" (No. 21), *q.v.*, and given also in the Leyden codex of the Fihrist.

(87) *K. al-Muntahā*. "The Book of the Conclusion." Mentioned by Jābir, loc. cit.

(88) *K. al-Khawāss al-Khamsīna*. "The Book of the Fifty Properties." Mentioned by Jābir in his *K. al-Zaibāq al-Gharbī* (No. 10).

(89) *K. al-Sumūm*. "The Book of Poisons." Mentioned by Jābir in his *K. al-Mawūzin* (No. 30), ed. Berthelot, op. cit., iii.

(90) *K. al-Adilla*. "The Book of Indications." Mentioned by Jābir, loc. cit.

(91) *K. Sifat al-Kawn*. "The Book of the Nature of Being." Mentioned by Jābir in the *K. al-Rahmat al-Saghīr*, ed. Berthelot, op. cit., iii.

(92) *K. Tadbīr al-Hukamā' al-Qudamā'*. "The Book of the Operation of the Ancient Sages." Mentioned by Jābir, loc. cit.

N.B.—In concluding this section it ought to be said that the translation of the titles of Arabic alchemical works without previous knowledge of the text is bound to be uncertain.

(3) AN ESTIMATE OF THE EXTENT OF JĀBIR'S CHEMICAL KNOWLEDGE AND OF HIS CONTRIBUTIONS TO CHEMISTRY.

To appreciate properly the value of Jābir's accomplishments it is necessary to have a general idea of the intellectual atmosphere of Islām in the second century of the Hijra, i.e., the eighth century A.D. In 749 A.D. the 'Umayyad dynasty was overthrown and was succeeded by that of the 'Abbasids. This change ushered in a period of intense literary activity, and, although some translations of Greek scientific and philosophical works had been made previously, it was in the last half of the century that the Muslims first became thoroughly intimate with Hellenic thought. The influence thus exercised soon began to bear fruit, learning was encouraged by the Caliphs, academies and observatories were founded, scholars welcomed, and thousands of books obtained from Alexandria, Byzantium and other seats of ancient culture.

Muslims of a scientific habit of mind turned naturally to philosophy, medicine and alchemy. The first two of these subjects presented no great difficulty, and, moreover, teachers were numerous. Chemistry, however, was in different case. It came to Islām via Alexandria, clothed in mysticism and infected with charlatanry and magic. It was a study despised and often considered to be unlawful; those who interested themselves in it were frequently driven to justify themselves by asserting that the prophets and even 'Alī ibn Abī Ṭālib had practised the art. No idea of chemistry as an independent and reasonable science seems to have penetrated to the intellectual aristocracy of Islām up to the middle of the eighth century.

Into this unfavourable environment Jābir was born. We may well sympathize with him when we consider the superhuman efforts any man of his time would have had to make to clear away the rank growth which surrounded chemistry and to establish the subject impregnably as a science of equal nobility with those of philosophy, mathematics and medicine. Yet this is the task which Jābir undertook and in which he achieved no small measure of success. The cold, impartial outlook which characterizes the man of science of to-day we should not expect to find in him—that is the heritage of centuries of patient progress. Neither should we expect to find in Jābir that calculating materialism and "suspense of judgment" which form so striking a feature of the present scientific age. A man must be judged by the intellectual background of his own time, and if we admit this criterion we shall come to place Jābir on a level with Boyle, Priestley and Lavoisier, as one of the pre-eminent figures in the history of chemistry.

A study of his works shows us that, while primarily a chemist, he was accomplished also in many other directions. Thus he wrote books on medicine; he wrote a commentary on Euclid and on the *Almagest*; he knew some of the writings or views of Plato, Socrates, Aristotle, Pythagoras and Democritus (which

he may have read in the original, as he appears to have known Greek); he wrote a treatise on Mirrors, another on Logic, another on Poetry; he interested himself in the newly-developed system of Sūfi-ism, and he studied the mystical ideas of Apollonius of Tyana. He was thus a widely-read scholar and not a petty mystagogue or charlatan; we can indeed be certain that the Barmekides—a very level-headed family—would otherwise not long have tolerated him.

Fortunately for chemistry, this man of genius and unbounded energy was drawn towards natural science, and, encouraged by the Imām Ja'far al-Sādiq, turned his attention to the study of the composition of substances obtained from minerals, plants and animals. His writings prove that this study meant to him not merely the reading of books but the close investigation of Nature and a stern discipline in the laboratory. It has to be said that Berthelot, having made up his mind—on what seem to be insufficient grounds—that the Latin Geber is not to be identified with the Arab Jābir ibn Ḥayyān, appears deliberately to underrate the latter; he certainly gives an entirely false idea of Jābir's scientific ability. A study of Jābir's works has led me to form a very high estimate of their author's mental calibre, and, whether he be the Latin Geber or no, he certainly had as fine an intelligence and as wide an experience. Some of the material upon which this judgment is based is here adduced.

(1) *Nature and Scope of Chemistry.*

Jābir defines chemistry¹ as "a branch of natural science, for it investigates mines and the manner in which, by the action of fire, metals are produced in them, since men desire by artificial means to imitate Nature. Everyone, indeed, who knows anything of [natural] philosophy realizes that the Art [of chemistry] imitates Nature and models itself on her. Now how can a man imitate a thing of which he knows nothing? As for those for whom this book is written, they hold steadfastly to the science therein and know its high place in philosophy."

He who studies chemistry must know that there are ten conditions to be observed for its successful practice. These are (1) the operator should know the reason for performing each operation; (2) the instructions must be properly understood, since every art has its own technical language; (3) the impossible and profitless should not be attempted; (4) time and reason must be carefully chosen [astrological influence]; (5) it is best for the laboratory to be in a secluded space; (6) the chemist must have trusty friends; (7) he must also have leisure to conduct his experiments, (8) and patience and reticence, (9) and perseverance; (10) he must not be deceived by appearances into bringing his operations to too hasty a conclusion.²

Although the main problem which chemistry set itself to solve in those days was the transmutation of the metals, Jābir did not allow this to become an obsession with him, and in numerous passages he describes the application of chemical knowledge to what we may term technical processes. The bulk of his writings certainly deal with theories of metallic constitution and are often couched in language which is difficult to understand: he was not completely successful in wresting himself clear from the trammels of mysticism. In spite of this, however, it is abundantly evident to anyone who reads his books that he made valiant efforts to attain to a reasonable scientific method. Where he failed was in trying to arrive at a comprehensive system—like most early scientists he explained too much. He had leanings also to the "number-

¹ *Book of Knowledge of the Divine Art and Philosophical Wisdom, vide supra*, No. 51.

² *Op. cit.*

mysticism" of Pythagoras, and his childish delight over magic squares and similar amusements shows that his mathematical ability could not have been very great.

(2) *Chemical Theories.*

In chemical theory Jābir shows a remarkable advance upon the Aristotelianism and pseudo-Aristotelianism which preceded him. He seems to have accepted in a general way the Aristotelian conceptions of the *prima materia*, the four "elements" and the "four qualities," but he developed more specialized theories of the constitution of metals and in doing so laid the foundations of the phlogiston theory, which, intellectually, is separated by only a short distance from Jābir's own ideas: in time, of course, there is an interval of some eight hundred years between them.

In the *Kitāb al-Idāh* (*supra*, No. 27, p. 50), he says:—

"The metals are all, in essence, composed of mercury combined and coagulated with sulphur; . . . they differ from one another only because of the difference of their accidental qualities, and this difference is due to the difference of their varieties of sulphur, which again is caused by a variation in the soils and in their positions with respect to the heat of the sun."

The most subtle sulphur is the golden, which, combined with mercury, forms a perfect compound—gold—distinguished from the other metals by the fact that it cannot be burnt but is stable in the fire. This passage is sufficient to show that Berthelot was wrong when he said that the "*œuvres arabes de Djāber n'offrent aucune trace*" of the sulphur-mercury theory of metals, "*théorie que l'on attribue en général à Geber.*"¹ The sulphur-mercury theory, however, appears to have been understood by Jābir not in the literal sense but as an approximation; he knew quite well that ordinary sulphur and mercury when combined gave rise not to a metal but to cinnabar, and therefore the "sulphur" and "mercury" of which metals are composed are not the "sulphur and mercury" of the vulgar, but rather hypothetical substances to which ordinary sulphur and mercury form the closest approximations. The combination of sulphur and mercury gives occasion to some very penetrating remarks by Jābir—remarks which show that he had some idea of the ancient atomic theories, and which, as an expression of his views on the nature of chemical combination, are not merely noteworthy, but astonishing in their clarity and perspicuity:—

"When mercury and sulphur combine to form one single substance, it has been thought that they have essentially changed and that an entirely new substance is formed. The fact is otherwise, however. Both the mercury and the sulphur retain their own natures—all that has happened is that their parts have become attenuated and in close approximation to one another, so that to the eye the product appears uniform. But if one could find an apparatus to separate the parts of one sort from those of the other, it would be apparent that each of them has remained in its own permanent natural form and has not been transmuted or changed. We say, indeed, that such transmutation is not possible for natural philosophers."²

(3) *Chemical Operations.*

Jābir was acquainted with the usual chemical operations such as solution, crystallization, calcination, reduction, &c., and often describes them. Of more interest, however, is the fact that he attempts to understand the changes that go on in these processes and frequently gives his opinion as to their aims. His method of reducing calces is illustrated by the following quotation:—

¹ Op. cit., i, 341.

² "Book of Knowledge of the Divine Art and Philosophical Wisdom, *vide supra*, No. 51.

³ *Kitāb al-Khawāss al-Kabir* (No. 21, *supra*), *maqāla* 88.

"Take a pound of litharge and a quarter of a pound of soda (*qali*) and powder each well. Then mix them together and make them up into a paste with oil and heat in a descensory. [The metal] will descend pure and white."

On calcination he wrote a book, the *Kitāb al-Taklīs* (No. 61, *supra*, p. 52), from which the passage below is quoted:—

"Souls and spirits [i.e., volatile substances like sulphur and sal-ammoniac] will not sustain calcination, since the latter can be effected only with a very hot fire; now spirits will not sustain a very hot fire as they are volatile and fly away from it. Moreover, the aim of calcination is nothing more than the removal of impurities from bodies and their complete combustion so that the bodies may be purified and remain unadulterated and unsullied; in a spirit, however, there is no necessity for the same treatment as a metallic body, and all that is needed is the first process in calcination [i.e., gentle heating], when the same effect is produced on the spirit as [complete] calcination effects on the metals, namely, full purification. Understand that clearly, therefore. As for the process which is to spirits what calcination is to metals, I swear by my Master that thou wilt find it to be sublimation, and on account of that we have devoted a book to sublimation, following the present book.

"As I have now made clear the aim of calcination I will next speak of its various forms, for each metal is calcined in a different way from the others. This is because among the metals are found some which are already pure, such as gold; in this case the object of calcination is to convert the metal into a fine powder so that it may be enabled to combine and enter into union with the sublimed spirits, and also to dissolve. The same applies to silver, but silver is slightly impure, so that along with the necessity for converting it into a fine powder is also that of purification.

"As for the rest of the metals, that is excluding the two above-mentioned, they indeed all require calcination both for purification and for converting them into powder; and the same is true for those minerals which are infusible, according to their degree of purity."

Two specimens of Jābir's instructions for preparing chemical compounds are appended. They are taken from the *K. al-Khwāṣṣ*, section (*maqāla*) 36.

(a) "Take a pound of litharge, powder it well and heat it gently with four pounds of wine vinegar until the latter is reduced to half its original volume. Then take a pound of soda and heat it with four pounds of fresh water until the volume of the latter is halved. Filter the two solutions until they are quite clear and then gradually add the solution of soda to that of the litharge. A white substance is formed which settles to the bottom. Pour off the supernatant water and leave the residue to dry. It will become a salt as white as snow."

(b) "To convert mercury into a red solid. Take a round glass vessel and pour a convenient quantity of mercury into it. Then take a Syrian earthenware vessel and in it put a little powdered yellow sulphur. Place the glass vessel on the sulphur and pack it round with more sulphur up to the brim. Place the apparatus in the furnace for a night, over a gentle fire . . . after having closed the mouth of the earthenware pot. Now take it out and you will find that the mercury has been converted into a hard red stone of the colour of blood. . . . It is the substance which men of science call cinnabar."

It is fitting to conclude this brief account of Jābir's life and works with his characteristic remarks on experiment:—

"The first essential in chemistry is that thou shouldst perform practical work and conduct experiments. For he who performs not practical work nor makes experiments will never attain to the least degree of mastery. But thou, O my son, do thou experiment so that thou mayst acquire knowledge."¹ "Scientists delight not in abundance of material; they rejoice only in the excellence of their experimental methods."²

¹ *Kitāb al-Tajrīd* (No. 57, *supra*, p. 52).

² *Kitāb al-Raḥmat al-Saghīr* (No. 55, *supra*).